Blockchains and Linked Data for Agrifood Value Chains

Christopher Brewster

TNO, The Netherlands

Platform Linked Data Nederland (PLDN) Workshop, Amersfoort, 6 December 2017

Outline

- The Challenge of Linked Data in the agrifood value chain
- The need for tracking and tracing
- The potential of Blockchain Technology
- Linked Pedigrees
- Linked Pedigrees on the a Blockchain
- Conclusions

TNO innovation for life

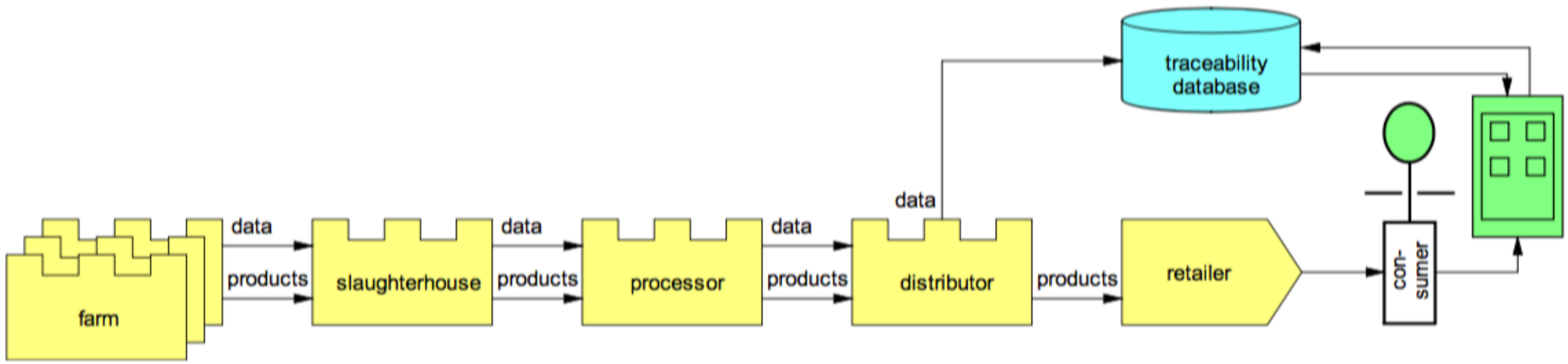
The Absence of Linked Data in the Value Chain

- Linked Data is largely absent from the value chain (i.e. from farm to consumer)
- Possible exception is Schema.org, and integration of the GoodRelations Ontology/Product Types Ontology.
- A few academic attempts to use ontologies in the **value chain** (See Tomic et al. 2015, Verhoosel et al. 2016, Solanki and Brewster 2015)
- Some limited *application* of Linked Data methods in value chain (e.g. BigTU Project)
- but no real uptake. Is this the wrong question?

The need for tracking and tracing

- Core challenge in value chain is tracking and tracing, due to food recall, food integrity issues and food crises.
  - Major importance in cases such as E.Coli (EHEC) 2011, horse meat 2013, or Italian Organic Food crisis 2011.
- EC's General Food Law (178/2002) requires *one up - one down* documentation (usually on paper, until relatively recently)
- Very slow system — it took **6 months** to map the horse meat supply chain.

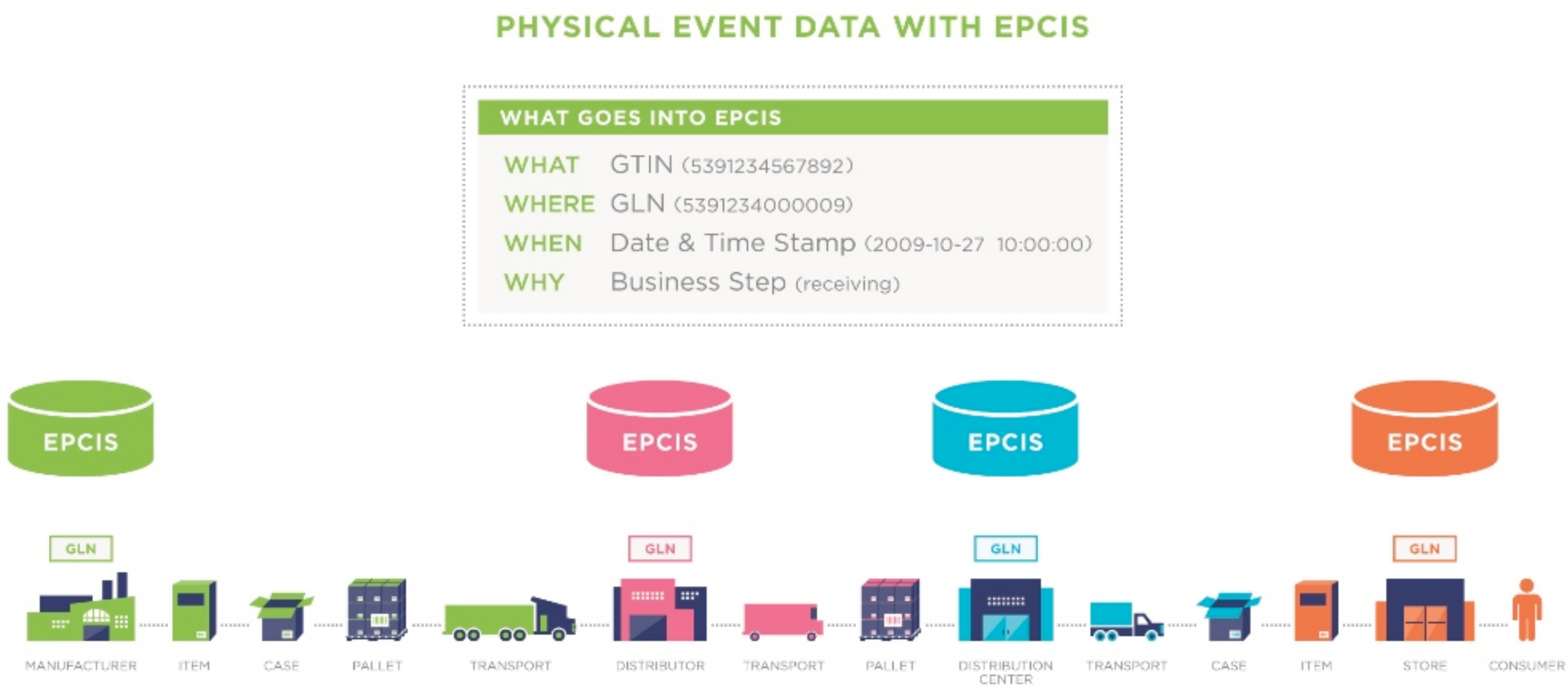
Current architecture



from Scholten et al. 2016

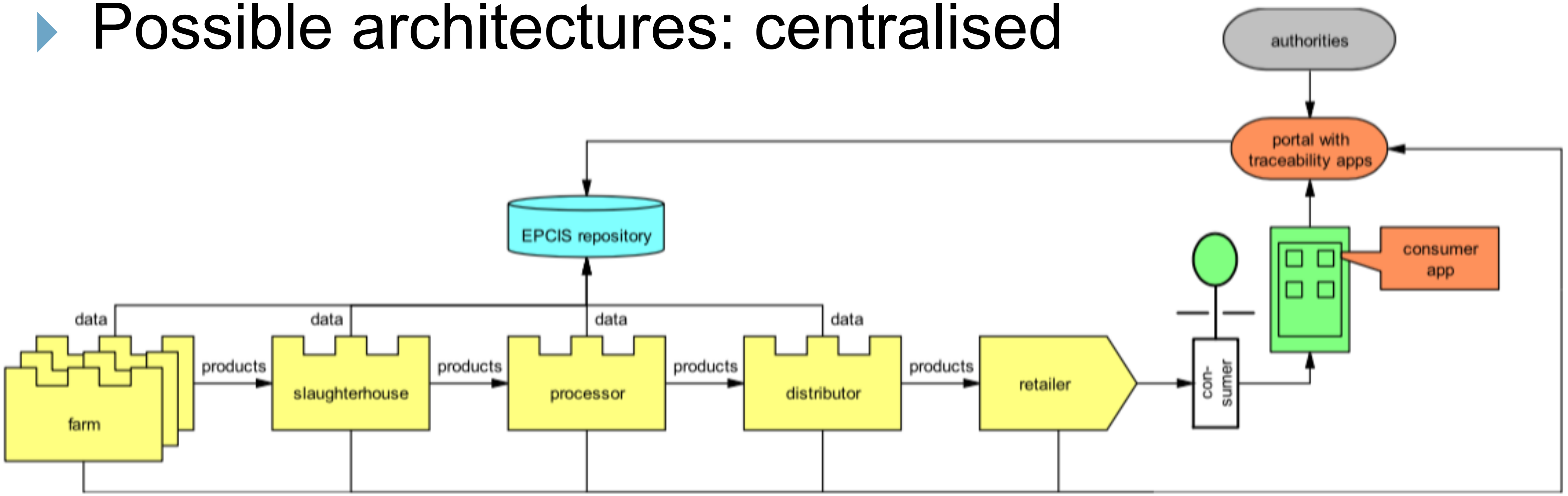
GS1 EPCIS

- Core standard in supply/value chain - used with barcodes and RFID
- Event based, each time you scan an EPCIS event data occurs
- Beyond that allows “barcode (GTIN) —> master data” look up



Problems with EPCIS

- Possible architectures: centralised

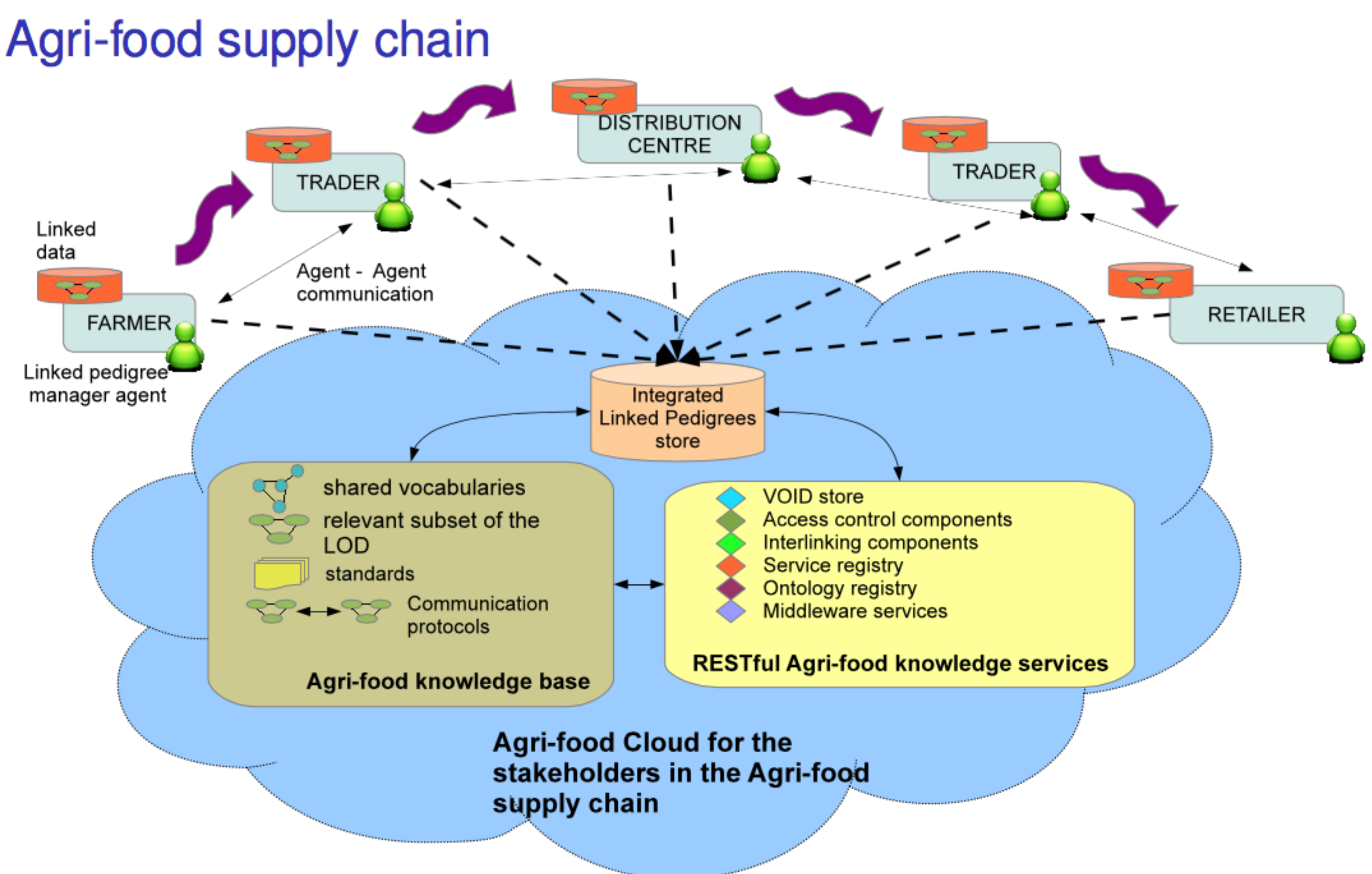


- Commercially/politically unacceptable

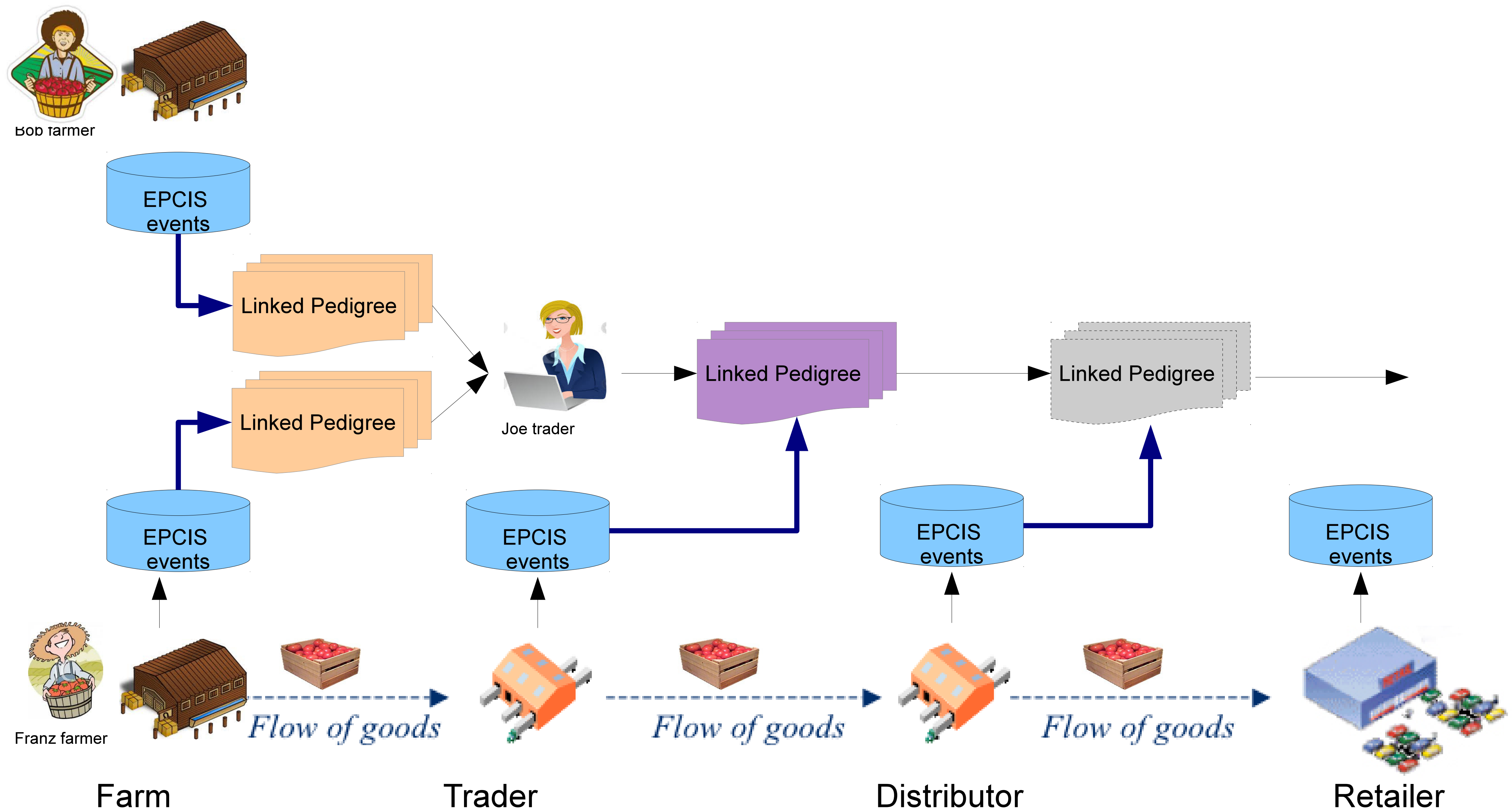
from Scholten et al. 2016

Possible approach: Linked Pedigrees

- Proposed 2-3 years ago (cf. Solanki and Brewster 2014/2015) - formalisation of EPCIS as Linked Data - using two ontologies.



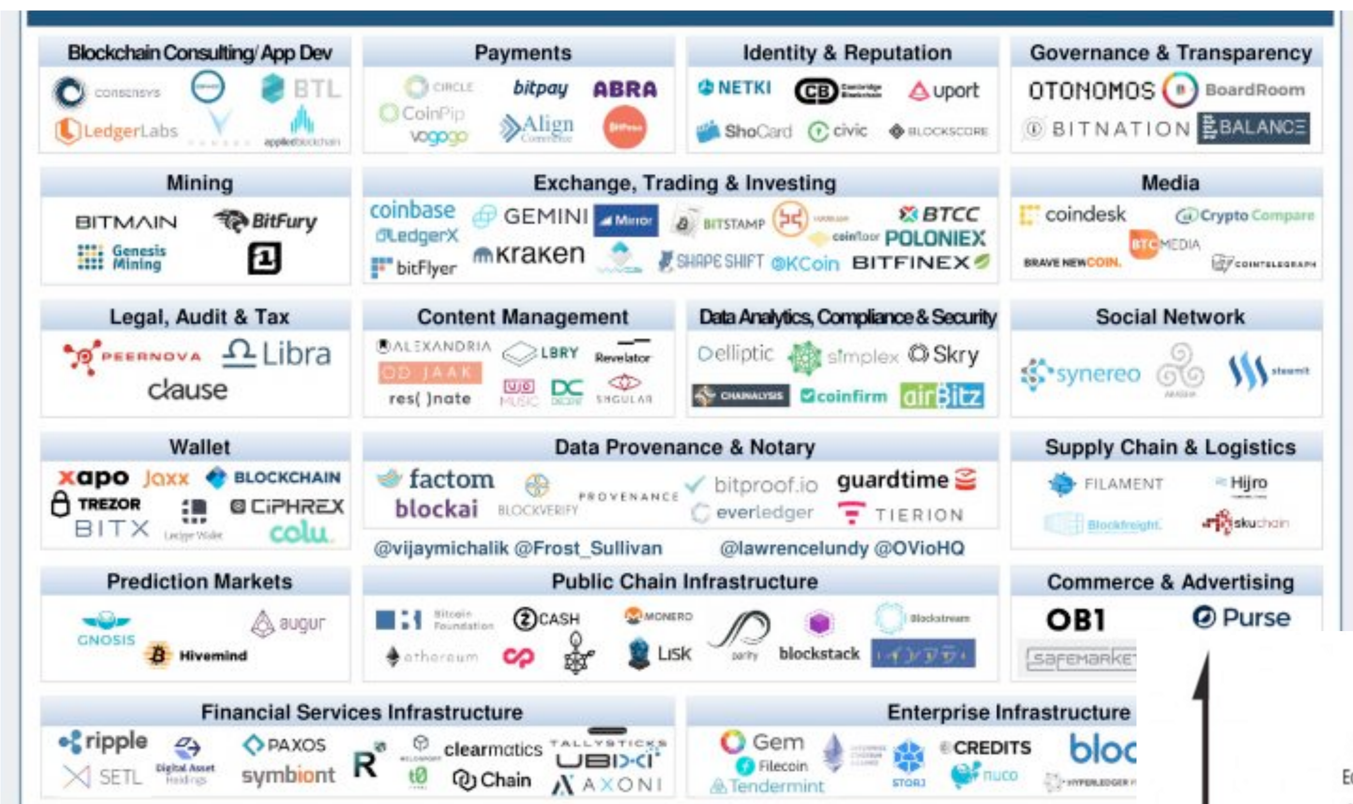
Result


Bob farmer
EPCIS events
Linked Pedigree
Linked Pedigree
Joe trader
Linked Pedigree
Linked Pedigree
EPCIS events
EPCIS events
EPCIS events
EPCIS events
Franz farmer
Flow of goods
Flow of goods
Flow of goods
Farm
Trader
Distributor
Retailer

PossibleTypical Queries

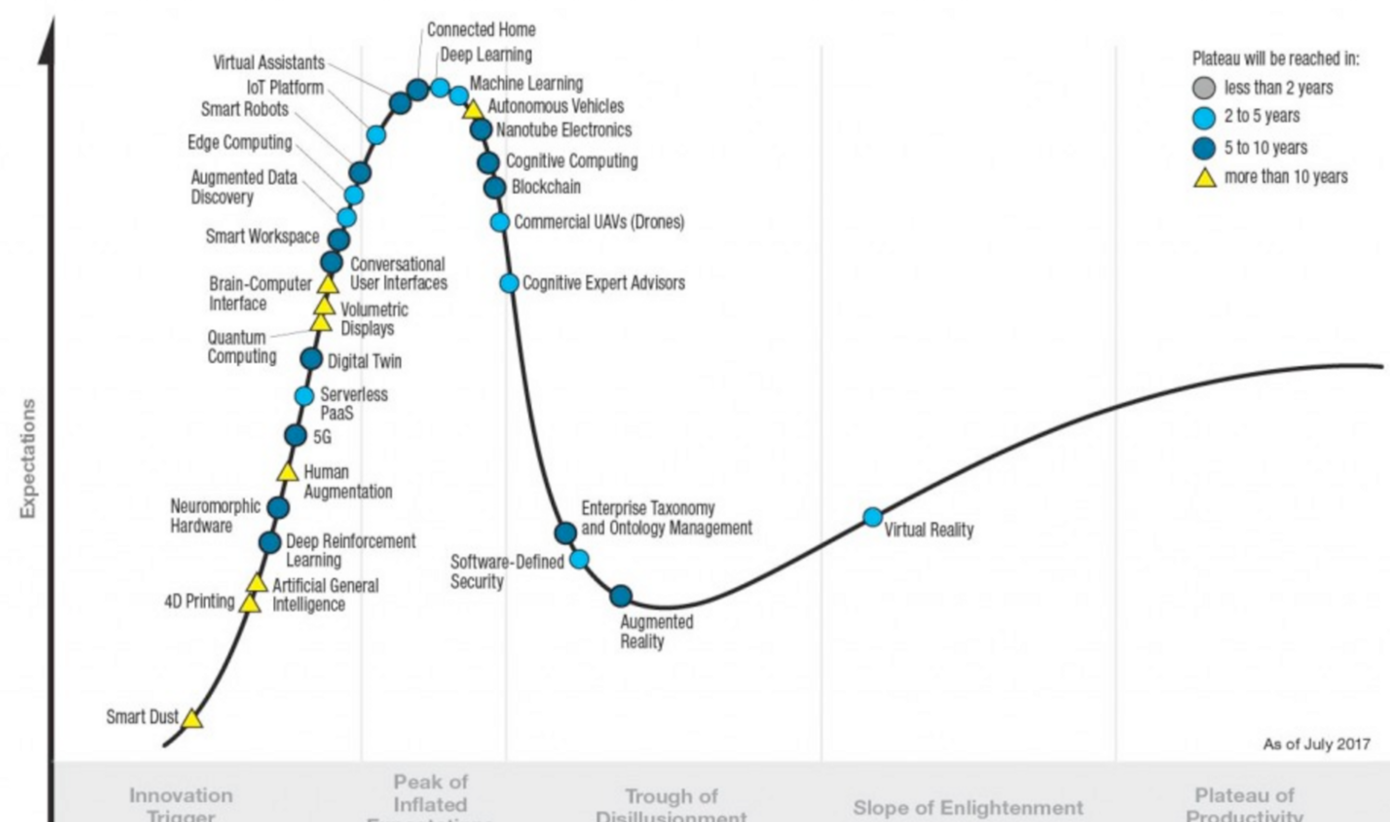
- Tracking ingredients: What were the inputs consumed during processing in the batch of wine bottles shipped on date X?
- Tracking provenance: Which winery staff were present at the winery when the wine bottles were aggregated in cases with identifiers X and Y?
- Tracking external data: Retrieve the average values for the growth temperature for grapes used in the production of a batch of wine to be shipped to Destination D on date X.

Blockchain Hype



HYPERLEDGER

https://ww2.frost.com/news/press-releases/frost-sullivan-identifies-2017-global-blockchain-startup-map/



http://thearea.org/gartner-hype-cycle-emerging-technologies-2017/

Supposed Blockchain Benefits

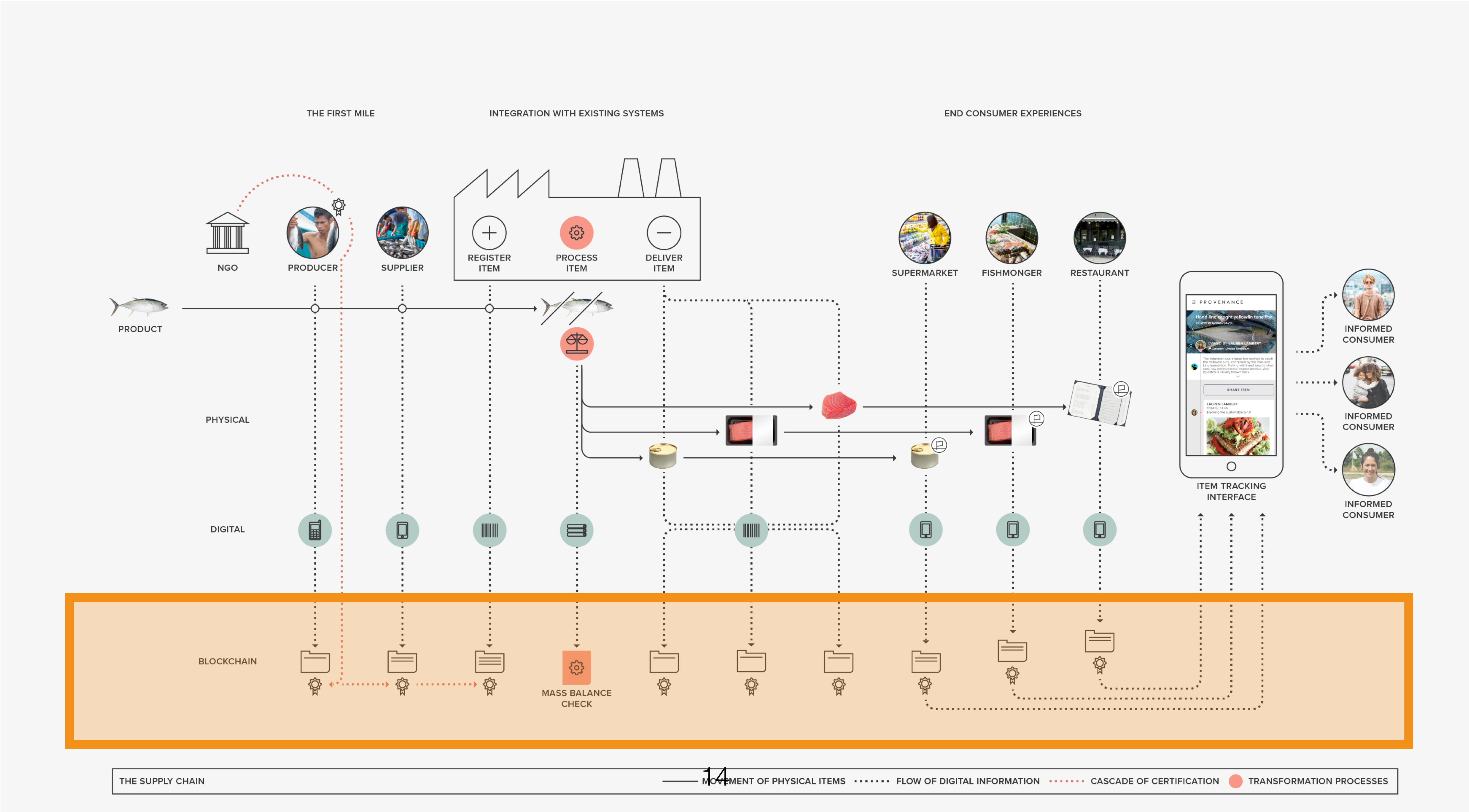
- **Decentralized / shared control** - situations where enemies need to work together for their mutual benefit, e.g. banks, perhaps in agrifood supply chains
- **Immutability / audit trail** - situations where it is of prime importance to have an immutable audit trail, where users cannot change data post hoc, e.g. Everledger for diamonds, perhaps for certification in agrifood
- **Assets / exchanges** - situations where the assets can live on the blockchain e.g. stock exchanges, currency or energy exchanges, perhaps for local agrifood marketplaces.

based on https://blog.bigchaindb.com/three-blockchain-benefits-ae3a2a5ab102#.2qi900pp9

Why blockchain in agrifood?

- Partly due to general hype that Blockchain is **a solution to everything**
- Partly due to the perception that Blockchain is a “universal database that all actors can transparently read and write to”.
- Partly due to ignorance - e.g. belief that it would be easy to put lots of data on the blockchain and control access (neither are true)

Provenance.org:Tune Fish Example



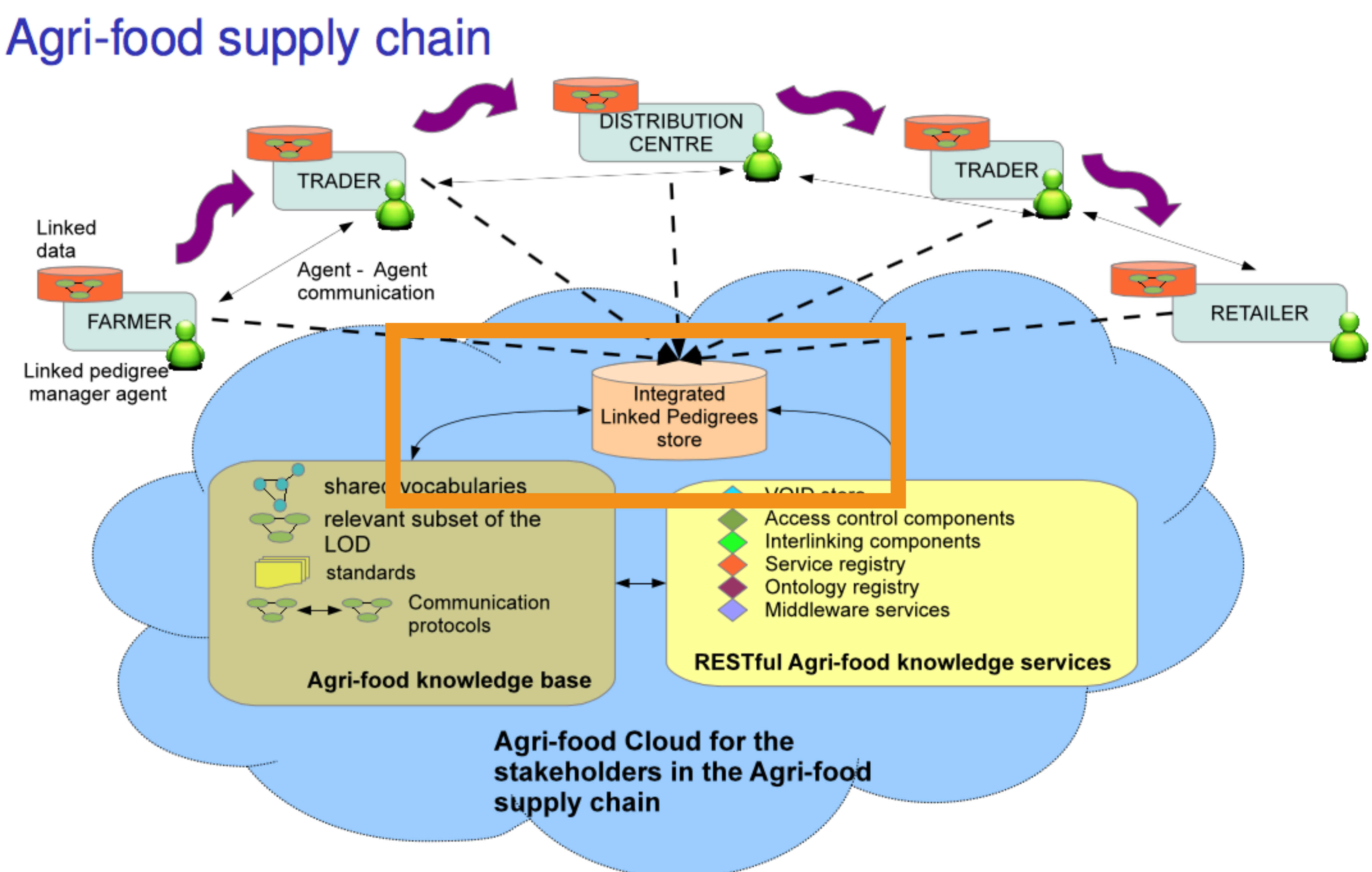
Provenance.org technical approach

- Most information is stored on the digital platform.
- **Ethereum blockchain** is used to store snapshots of data (e.g. food certification, or data from smart phone app).
- Blockchain provides **immutable proof** that the data was true at a certain point in time, using hash of data placed on public Ethereum blockchain.
- Data on *platform* can be queried and compared with hash. Data on the blockchain can only be *compared* for integrity.
- **Because current blockchain technology is very limited**

How to use Blockchains and Linked Data

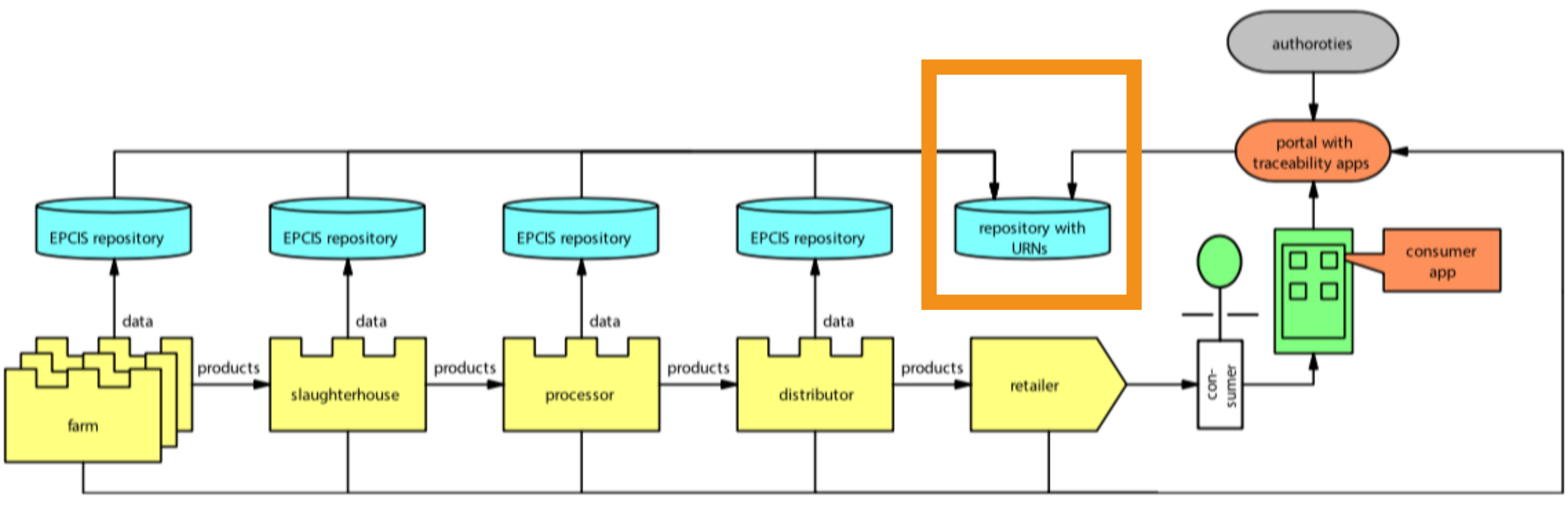
- Use GS1's EPCIS standard to generate traceability event data.
- Each actor has their own repository/database
- Expose RDF based Linked Pedigrees with URIs/ URNs
- Use a blockchain to store only URIs

Linked Pedigrees on a Blockchain



Not dissimilar to …

- Scholten et al. 2016 proposed but "unfeasible" architecture



Linked Pedigrees on a blockchain

- Allows permanent recording of food product trajectory
- Multiparty encryption can allow access only under given conditions or roles
- Potentially overcomes trust and permanence issues characteristic of food value chain.
- Remember the Italian organic scandal ….

Conclusions

- Blockchain technology is far more limited in its application than most people allow
- One **good** use case is in food traceability
- Combination of lack of trust between participants and need for permanent records creates and opportunity for blockchain + linked data

Acknowledgements

- Research partially supported by the Dutch national Techruption Blockchain project http://techruption.org/
- For TNO's work on blockchains consult https://blockchain.tno.nl/

References

- Monika Solanki and Christopher Brewster. “Enhancing visibility in EPCIS governing Agri- food Supply Chains via Linked Pedigrees.” International Journal on Semantic Web and Information Systems 10, 45–73 (2015), URL http: //cbrewster.com/papers/Solanki_IJSWIS15.pdf

- Monika Solanki and Christopher Brewster. “EPCIS event based traceability in pharmaceu- tical supply chains via automated generation of linked pedigrees.” In International Semantic Web Conference 2014 (ISWC 2014) (Rivo di Garda, 2014).URL http://www.cbrewster.com/papers/Solanki_ISWC14.pdf

- Verhoosel, J., van Bekkum, M., & Verwaart, T. (2016). HortiCube: A Platform for Transparent, Trusted Data Sharing in the Food Supply Chain. In J. Deiters, U. Rickert, & G. Schiefer (Eds.), Proceedings of the 10th International European Forum on System Dynamics and Innovation in Food Network (Vol. 0, pp. 384–388). Innsbruck: International Center for Food Chain and Network Research, University of Bonn, Germany. https://doi.org/10.18461/pfsd.2016.1642

- Tomic, D., Drenjanac, D., Hoermann, S., & Auer, W. (2015). Experiences with creating a Precision Dairy Farming Ontology (DFO) and a Knowledge Graph for the Data Integration Platform in agriOpenLink. Journal of Agricultural Informatics, 6(4), 115–126. Retrieved from http://real.mtak.hu/30173/1/213_1071_1_PB_u.pdf